LAKEFIELD RESEARCH
A DIVISION OF FALCONBRIDGE LIMITED
LAKEFIELD, ONTARIO, CANADA

Open File Report 89-2

AN INVESTIGATION OF THE RECOVERY OF ANTIMONY FROM SAMPLES SUBMITTED BY DURHAM RESOURCES INC.

PROGRESS REPORT NO. 2

by

Lakefield Research
A Division of Falconbridge Limited

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Entente Canada-Nouveau-Brunswick L'Exploitation Minérale

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An Investigation of

THE RECOVERY OF ANTIMONY

from samples

submitted by

DURHAM RESOURCES INC.

Progress Report No. 2

Project No. L.R. 3161

NOTE:

This report refers to the samples as received.

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LAKEFIELD RESEARCH
A DIVISION OF FALCONBRIDGE LIMITED
December 15, 1986

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ABSTRACT

Flotation tests were conducted on a sample of mill feed assaying 2.74 % Sb. Mineralogical examination indicated that the antimony mineral composition of the sample was 81 % stibnite, 10 % berthierite, 5 % native antimony and 4 % gudmundite.

The results showed that conditioning the rougher feed pulp with sulphuric acid to pH 6.5 improved antimony flotation.

The final cleaner concentrates assayed 67 - 69 % Sb at 80 - 83 % recovery in batch tests.

Antimony losses in the flotation tailings were attributed to finely dispersed middling grains and -10 μm slime.

INTRODUCTION

On September 4, 1986 a sample of mill feed to the Lake George antimony concentrator, representing the milling period from August 15 to August 20, was received at Lakefield Research.

In a telephone conversation on August 14 Mr. Victor Hendricken of Durham Resources discussed the changing mineralogy of the mill feed, as determined by the Research and Productivity Council, and the subsequent effect on mill performance.

The native antimony and berthierite, $FeSb_2S_4$, contents of the mill feed were variable but increasing. Various stopes contained 10-30 % of the antimony as native antimony and 10 - 20 % as berthierite. The concentrator was recovering 90 - 95 % of the stibnite content of the ore but only 50 % of the berthierite and less than 50 % of the native antimony, as determined by quantitative mineralogical examination at RPC.

Mr. Hendricken requested flotation testwork on a current sample of mill feed which should contain more native antimony and berthierite than mill feeds 1 and 2, reported in Progress Report No. 1.

Current concentrator performance was a concentrate grade of 59 - 67 % Sb from a 2 % Sb feed assay. Mill tailings could range from 0.4 to 0.7 % Sb over 24 hours.

Introduction - Cont'd

In a subsequent telephone conversation on October 15, Mr. Hendricken reported that the concentrator performance had stabilized and concentrate grades of 60 - 63 % Sb were being produced at 86 - 88 % recovery. The mill tailing assay was down to 0.3 % Sb.

LAKEFIELD RESEARCH

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SUMMARY

1. Head Analysis

A representative sample of mill feed 3 assayed 2.74 % Sb, 0.37 % As, 0.012 % Pb and 2.33 % S.

2. Mineralogy

A sample of mill feed, representative of mill feed 3, was sent by Mr. Mr. Hendricken directly to the Research and Productivity Council in Fredericton, New Brunswick for mineralogical examination.

The examination showed that the distribution of antimony minerals in the sample was as follows (1):

Mineral	Formula	Mineral Distribution	Locked Grains
Stibnite	Sb_2S_3	81 %	23 %
Native antimony	Sb	5 %	60 %
Berthierite	$FeSb_2S_4$	10 %	60 %
Gudmundite	FeSbS	4 %	50 %

Stibnite and berthierite represented 91 % of the antimony minerals in the sample.

23 % of the stibnite and 60 % of the berthierite were present as locked grains. Most of the locked stibnite occurred as small inclusions (<20 μm diameter) within gangue and represented < 10 % of the locked grain. Most of the locked berthierite occurred as fine needles and blebs (< 20 μm diameter) within gangue and also represented < 10 % of the locked grains.

(1) J. Melluish, RPC Mineralogical Report M/86/023, September 16, 1986

Summary - Continued

3. Flotation

3.1. Rougher Flotation

A series of rougher flotation tests were conducted to examine the effect of sulphuric acid, lead nitrate and 3477 collector additions on antimony and arsenic flotation.

The results which are contained in Table No. 1 indicated that conditioning the rougher feed pulp with sulphuric acid to pH 6.5 improved antimony flotation. Arsenic flotation was also increased. This data confirmed the results by Davis et al(2). They suggested that berthierite and gudmundite flotation were both improved at lower pH.

There was a large variation in the amount of weight floated with the sulphuric acid addition. Rougher concentrate weight recovery ranged from 10 to 25 % at 88 to 94 % Sb recovery. The 1st cleaner tailing contained most of the excess gangue floated in the rougher concentrate and the system had stabilized after two cleaning stages.

Several identical tests did not reduce the range of weight floated in the rougher concentrate. It was concluded that the rougher reagent system was sufficiently powerful to collect the locked mineral grains. Dilution in cleaning weakened the collector bond and the locked grains were not floated.

(2) D.R. Davis et al, Antimony in South Africa, J.S Afr. Inst. Min. Metall. Vol. 86, No. 6, June 1986, pp 173-193

Summary - Continued

3.1. Rougher Flotation - Cont'd

Table No. 1 - Rougher Flotation

Test No.	Grind Size %-200 Mesh	H_2SO_4 g/t	$Pb(NO_3)_2$ g/t	3477 g/t	Rougher Concentrate					Investigation
					Wgt. %	Assay, %		% Distr.		
						Sb	As	Sb	As	
36	80	-	500	40	17.5	9.7	-	61.0	-	Reagents
42	80	-	625	40	14.4	16.0	0.37	82.7	14.0	
33	80	-	625	80	21.7	12.0	0.37	91.7	22.2	
34	80	200	625	80	25.0	10.3	0.57	92.7	36.5	Reagents
38	80	500	375	40	21.6	8.7	-	77.3	-	Reagents
39	80	500	500	60	18.3	13.8	-	91.1	-	
37	80	500	625	40	25.3	10.3	-	94.3	-	
35	80	500	625	80	25.0	10.2	0.64	92.9	43.2	
44	90	500	625	40	24.4	10.9	-	94.0	-	Grind
41	80	500	625	40	10.4	23.7	0.62	88.4	17.8	Reproducibility
45	80	500	625	40	11.2	22.9	0.65	90.9	19.9	
40	80	500	625	40	17.1	13.9	-	87.5	-	
43	80	500	625	40	24.5	11.0	-	93.6	-	
37	80	500	625	40	25.3	10.3	-	94.3	-	

3.2. Cleaner Flotation

Lead nitrate additions were required throughout cleaner flotation to maintain antimony recovery. Sulphuric acid additions to maintain pH 6.2-6.5 in cleaner flotation reduced antimony grade.

The best results were achieved at a primary grind of 80 % -200 mesh with 500 g/t H_2SO_4, 625 g/t $Pb(NO_3)_2$ and 40 g/t 3477 in rougher flotation at pH 6.5 followed by 90 g/t $Pb(NO_3)_2$ additions (total) to cleaner flotation at natural pH 7.0 - 7.2

The final cleaner concentrate assayed 67 - 69 % Sb at 80 - 83 % recovery.

Similar flotation conditions at natural pH in the rougher produced about 5 % lower antimony recovery.

The arsenic analyses of the cleaner concentrate ranged from 0.15 % to 0.20 % As regardless of sulphuric additions to the rougher.

The results are contained in Table No. 2.

Summary - Continued

3.2. Cleaner Flotation - Cont'd

Table No. 2 - Cleaner Flotation

Test	Grind Size	Rougher Flotation								Cleaner Flotation							Head Head Assay %	
		Conditions			Rougher Concentrate					Conditions		3rd Cl. Concentrate						
						Assay %		% Distr.					Assay %		% Distr.		(Calc.)	
No.	%-200 Mesh	H_2SO_4 g/t	$Pb(NO_3)_2$ g/t	3477 g/t	Wgt. %	Sb	As	Sb	As	H_2SO_4 g/t	$Pb(NO_3)_2$ g/t	Wgt. %	Sb	As	Sb	As	Sb	As
40	80	500	625	40	17.1	13.9	-	87.5	-	-	-	1.9	66.5	-	47.1	-	2.71	-
41	80	500	625	40	10.4	23.7	0.62	88.4	17.8	-	90	3.3	67.0	0.20	79.8	1.8	2.79	0.36
42	80	-	625	40	14.4	16.0	0.37	82.7	14.0	-	90	3.1	66.9	0.16	75.2	1.2	2.78	0.38
43	80	500	625	40	24.5	11.0	-	93.6	-	325	90	4.7	53.4	-	87.7	-	2.87	-
45	80	500	625	40	11.2	22.9	0.65	90.9	19.9	-	90	3.4	68.4	0.17	83.1	1.6	2.83	0.37

DISCUSSION AND RECOMMENDATIONS

Reduced pH with sulphuric acid appeared to improve berthierite flotation and might be beneficial in closed circuit mill flotation.

The main cause of antimony loss in the flotation tailings was the presense of <20 μm inclusions of stibnite, berthierite, native antimony and gudmundite in the mill feed. The exposed surface of the antimony minerals in the locked grains was less than 10 % of the total surface of the locked grain.

Because of the relative friability of antimony minerals in general these locked grains should be considered as unrecoverable.

SAMPLE PREPARATION

On September 4, 1986, four pails of damp mill feed representing the milling period August 15 to August 20 were received at Lakefield Research and given Reference Number 8626761.

The contents of the pails were combined, dried, cone and roll crushed to -10 mesh and riffled into 2 kg test charges and a head sample for analysis.

The sample was labelled mill feed 3.

INVENTORY

A total of 32 x 2 kg test charges of mill feed 3 remain on hand at Lakefield.

DETAILS OF TESTS

Test No. 31

Purpose: To investigate flotation of Mill Feed 3 under standard flotation conditions.

Procedure: As outlined below.

Feed: 2000 grams minus 10 mesh Mill Feed 3.

Grind: 30 minutes at 59 percent solids in the lab ball mill.

Conditions:

Stage	Reagents Added, grams per tonne					Time, minutes			pH
	$Pb(NO_3)_2$	3477	MIBC	Na_2SO_3	A350/ FA1/OP6	Grind	Cond.	Froth	
Grind	-	-	-	-	-	30	-	-	-
Rougher	250	40	10	-	-	-	2	5	7.5
	250	20	-	-	-	-	2	5	-
	125	20	-	-	-	-	2	5	-
Scavenger	-	-	-	250	-	-	2	-	7.7
	-	-	-	-	20	-	2	3	-
Ro. 1st Cl.	100	-	5	-	-	-	2	5	6.9
	-	5	-	-	-	-	1	3	-
Ro. 2nd Cl.	50	5	-	-	-	-	2	5	6.7
Ro. 3rd Cl.	30	-	-	-	-	-	2	4	6.7
Scav. 1st Cl.	-	-	-	100	-	-	1	3	7.8
Scav. 2nd Cl.	-	-	-	-	-	-	1	-	7.3

Test No. 31 - Continued

Metallurgical Results

Product	Weight %	Assays, % Sb	% Distribution Sb
1. Sb Ro. 3rd Cl. Conc.	4.69	52.5	89.7
2. Sb Ro. 3rd Cl. Tail.	0.64	2.78	0.6
3. Sb Ro. 2nd Cl. Tail.	1.85	1.05	0.7
4. Sb Ro. 1st Cl. Tail.	9.93	0.58	2.1
5. Sb Scav. 2nd Cl. Conc.	1.18	1.76	0.8
6. Sb Scav. 2nd Cl. Tail.	0.67	2.08	0.5
7. Sb scav. 1st Cl. Tail.	1.91	0.94	0.7
8. Sb Scav. Tailing	79.13	0.17	4.9
Head (Calculated)	100.00	2.74	100.0

Calculated Grades and Recoveries

Products 1 and 2	5.33	46.5	90.3
Products 1 to 3	7.18	34.8	91.0
Products 1 to 4	17.11	15.0	93.1
Products 5 and 6	1.85	1.88	1.3
Products 5 to 7	3.76	1.40	2.0
Products 5 to 8	82.89	0.23	6.9
Products 1 and 5	5.87	43.9	93.9

Test No. 32

Purpose: To investigate flotation of Mill Feed 3 using A3-3 and $CuSO_4$.

Procedure: As outlined below.

Feed: 2000 grams minus 10 mesh Mill Feed 3.

Grind: 30 minutes at 60 percent solids in the lab ball mill.

Conditions:

Stage	Reagents Added, grams per tonne				Time, minutes			pH
	A3-3	$CuSO_4$	A350/ FA1/OP6	MIBC	Grind	Cond.	Froth	
Grind	-	-	-	-	30	-	-	-
Rougher	150	-	-	-	-	5	-	7.4
	-	300	25	40	-	2	8	6.9
	-	20	5	-	-	2	4	-
1st Cleaner	25	-	-	-	-	1	7	7.1
2nd Cleaner	-	-	-	-	-	1	4	-

Metallurgical Results

Product	Weight	Assays, %	% Distribution
	%	Sb	Sb
1. Sb 2nd Cl. Conc.	5.98	14.0	30.8
2. Sb 2nd Cl. Tail.	2.10	3.67	2.8
3. Sb 1st Cl. Tail.	9.80	1.96	7.1
4. Sb Rougher Tail.	82.12	1.96	59.3
Head (Calculated)	100.00	2.72	100.0

Calculated Grades and Recoveries

Products 1 and 2	8.08	11.3	33.6
Products 1 to 3	17.88	6.19	40.7

Test No. 33

Purpose: To investigate rougher flotation.

Procedure: As outlined below.

Feed: 2000 grams minus 10 mesh Mill Feed 3.

Grind: 30 minutes at 59 % solids in lab ball mill.

Conditions:

Stage	Reagents Added, grams per tonne			Time, minutes			pH
	$Pb(NO_3)_2$	3477	MIBC	Grind	Cond.	Froth	
Grind	-	-	-	30	-	-	-
Rougher 1	250	40	10	-	2	5	7.4
Rougher 2	250	20	-	-	2	5	-
Rougher 3	125	20	-	-	2	5	-

Test No. 33 - Continued

3161-33 Metallurgical Balance

Product	Weight %	Assays,% Sb	As	% Distribution Sb	As
1. Ro Conc 1	6.80	18.70	0.47	45.05	8.82
2. Ro Conc 2	7.24	13.60	0.31	34.87	6.19
3. Ro Conc 3	7.61	4.36	0.24	11.75	7.14
4. Ro Tail	78.35	0.30	0.36	8.33	77.84
Head(calc)	100.00	2.82	0.36	100.00	100.00
Combined Products					
1+2	14.04	16.07	0.39	79.92	15.02
1to 3	21.65	11.95	0.37	91.67	22.16

Test No. 34

Purpose: To investigate rougher flotation at pH 7.0.

Procedure: As outlined below.

Feed: 2000 grams minus 10 mesh Mill Feed 3.

Grind: 30 minutes at 59 % solids in the lab ball mill.

Conditions:

Stage	Reagents Added, grams per tonne				Time, minutes			pH
	$Pb(NO_3)_2$	3477	MIBC	H_2SO_4	Grind	Cond.	Froth	
Grind	-	-	-	-	30	-	-	-
Condition	-	-	-	200	-	5	-	7.0
Rougher 1	250	40	10	-	-	2	5	6.8
Rougher 2	250	20	-	-	-	2	5	6.8
Rougher 3	125	20	-	-	-	2	5	7.0

Test No. 34 - Continued

3161-34 Metallurgical Balance

Product	Weight %	Assays,% Sb	As	% Distribution Sb	As
1. Ro Conc 1	9.22	16.00	1.04	53.18	24.62
2. Ro Conc 2	9.83	10.40	0.30	36.86	7.57
3. Ro Conc 3	6.00	1.23	0.28	2.66	4.32
4. Ro Tail	74.94	0.27	0.33	7.29	63.49
Head(calc)	100.00	2.77	0.39	100.00	100.00
Combined Products					
1 + 2	19.05	13.11	0.66	90.04	32.19
1 to 3	25.06	10.26	0.57	92.71	36.51

Test No. 35

Purpose: To investigate rougher flotation at pH 6.5

Procedure: As outlined below.

Feed: 2000 grams minus 10 mesh Mill Feed 3.

Grind: 30 minutes at 59 % solids in lab ball mill.

Conditions:

Stage	Reagents Added, grams per tonne				Time, minutes			pH
	$Pb(NO_3)_2$	3477	MIBC	H_2SO_4	Grind	Cond.	Froth	
Grind	-	-	-	-	30	-	-	-
Condition	-	-	-	500	-	5	-	6.5
Rougher 1	250	40	10	-	-	2	5	6.4
Rougher 2	250	20	-	-	-	2	5	6.5
Rougher 3	125	20	-	50	-	2	5	6.5

Test No. 35 - Continued

3161-35 Metallurgical Balance

Product	Weight %	Assays,% Sb	As	% Distribution Sb	As
1. Ro Conc 1	12.14	13.50	1.05	59.51	34.49
2. Ro Conc 2	9.72	9.20	0.25	32.46	6.57
3. Ro Conc 3	3.14	0.83	0.25	0.95	2.12
4. Ro Tail	75.00	0.26	0.28	7.08	56.81
Head(calc)	100.00	2.75	0.37	100.00	100.00
Combined Products					
1 + 2	21.86	11.59	0.69	91.97	41.06
1 to 3	25.00	10.24	0.64	92.92	43.19

Test No. 36

Purpose: To examine the effect of reducing collector levels in roughing at natural pH.

Procedure: As outlined below.

Feed: 2000 g minus 10 mesh.

Grind: 30 minutes at 59 % solids in the lab ball mill.

Conditions:

Stage	Reagents Added, grams per tonne			Time, minutes			pH
	$Pb(NO_3)_2$	3477	MIBC	Grind	Cond.	Froth	
Grind	-	-	-	30	-	-	-
Rougher 1	250	20	20	-	2	5	-
Rougher 2	125	10	-	-	2	5	-
Rougher 3	125	10	5	-	2	5	-

Metallurgical Results

Product	Weight	Assays, %	% Distribution
	%	Sb	Sb
1. Ro. Concentrate 1	6.80	15.1	36.8
2. Ro. Concentrate 2	5.43	6.81	13.3
3. Ro. Concentrate 3	5.24	5.78	10.9
4. Rougher Tailing	82.53	1.32	39.0
Head (Calculated)	100.00	2.79	100.0

Calculated Grades and Recoveries

Products 1 and 2	12.23	11.4	50.1
Products 1 to 3	17.47	9.73	61.0

Test No. 37

Purpose: To repeat conditions of test No. 35 with reduced collector.

Procedure: As outlined below.

Feed: 2000 grams minus 10 mesh Mill Feed 3

Grind: 30 minutes at 59 % solids in the lab ball mill.

Conditions:

Stage	Reagents Added, grams per tonne				Time, minutes			pH
	$Pb(NO_3)_2$	3477	MIBC	H_2SO_4	Grind	Cond.	Froth	
Grind	-	-	-	-	30	-	-	-
Condition	-	-	-	500	-	5	-	6.5
Rougher 1	250	20	10	-	-	2	5	-
Rougher 2	250	10	10	-	-	2	5	-
Rougher 3	125	10	-	--	-	2	5	-

Metallurgical Results

Product	Weight	Assays, %	% Distribution
	%	Sb	Sb
1. Rougher Conc. 1	10.21	13.4	49.5
2. Rougher Conc. 2	7.75	12.3	34.5
3. Rougher Conc. 3	7.35	3.87	10.3
4. Rougher Tail.	74.69	0.21	5.7
Head (Calculated)	100.00	2.76	100.0

Calculated Grades and Recoveries

Products 1 and 2	17.96	12.9	84.0
Products 1 to 3	25.31	10.3	94.3

Test No. 38

Purpose: To repeat conditions of test No. 37 with reduced $Pb(NO_3)_2$.

Procedure: As outlined below.

Feed: 2000 grams minus 10 mesh Mill Feed 3.

Grind: 30 minutes at 59 % solids in the lab ball mill.

Conditions:

Stage	Reagents Added, grams per tonne				Time, minutes			pH
	$Pb(NO_3)_2$	3477	MIBC	H_2SO_4	Grind	Cond.	Froth	
Grind	-	-	-	-	30	-	-	-
Condition	-	-	-	500	-	5	-	6.5
Rougher 1	125	20	10	-	-	2	5	-
Rougher 2	125	10	7.5	-	-	2	5	-
Rougher 3	125	10	-	-	-	2	5	-

Metallurgical Results

Product	Weight	Assays, %	% Distribution
	%	Sb	Sb
1. Rougher Conc. 1	8.19	12.2	35.7
2. Rougher Conc. 2	5.73	9.24	18.9
3. Rougher Conc. 3	7.67	4.64	12.7
4. Rougher Tailing	78.41	1.17	32.7
Head (Calculated)	100.00	2.80	100.0

Calculated Grades and Recoveries

Products 1 and 2	13.92	11.0	54.6
Products 1 to 3	21.59	8.73	77.3

Test No. 39

Purpose: To repeat rougher conditions of test No. 35 and clean combined rougher concentrates 1 and 2.

Procedure: As outlined below.

Feed: 2000 grams minus 10 mesh Mill Feed 3.

Grind: 30 minutes at 59 % solids in the lab ball mill.

Conditions:

Stage	Reagents Added, grams per tonne				Time, minutes			pH
	$Pb(NO_3)_2$	3477	MIBC	H_2SO_4	Grind	Cond.	Froth	
Grind	-	-	-	-	30	-	-	-
Condition	-	-	-	500	-	5	-	6.5
Rougher	250	40	10	-	-	2	5	6.9
	250	20	-	-	-	2	5	-
1st Cleaner	50	-	7.5	-	-	2	4	6.9
2nd Cleaner	25	-	5	-	-	2	4	7.0
3rd Cleaner	15	-	-	-	-	2	4	7.2

Metallurgical Results

Product	Weight	Assays, %	% Distribution
	%	Sb	Sb
1. 3rd Cleaner Conc.	4.25	54.4	83.5
2. 3rd Cleaner Tail.	0.83	3.00	0.9
3. 2nd Cleaner Tail.	1.94	1.19	0.8
4. 1st Cleaner Tail.	11.31	1.45	5.9
5. Rougher Tail.	81.66	0.30	8.9
Head (Calculated)	100.00	2.77	100.0

Calculated Grades and Recoveries

Products 1 and 2	5.09	45.9	84.4
Products 1 to 3	7.03	33.6	85.2
Products 1 to 4	18.34	13.8	91.1

Test No. 40

Purpose: To repeat conditions of test No. 37 but clean without further reagent additions.

Procedure: As outlined below.

Feed: 2000 grams minus 10 mesh Mill Feed 3.

Grind: 30 minutes at 59 % solids in the lab ball mill.

Conditions:

Stage	Reagents Added, grams per tonne				Time, minutes			pH
	H_2SO_4	$Pb(NO_3)_2$	3477	MIBC	Grind	Cond.	Froth	
Grind	-	-	-	-	30	-	-	7.9
Condition	500	-	-	-	-	5	-	6.4
Rougher	-	250	20	17.5	-	2	5	6.9
	-	250	10	10	-	2	5	-
	-	125	10	-	-	2	5	-
1st Cleaner	-	-	-	-	-	2	10	7.3
2nd Cleaner	-	-	-	-	-	2	8	7.4
3rd Cleaner	-	-	-	5	-	2	8	-

Metallurgical Results

Product	Weight	Assays, %	% Distribution
	%	Sb	Sb
1. Sb 3rd Cl. Conc.	1.92	66.5	47.1
2. Sb 3rd Cl. Tail.	0.24	31.2	2.8
3. Sb 2nd Cl. Tail.	1.08	7.80	3.1
4. Sb 1st Cl. Tail.	13.83	6.75	34.5
5. Rougher Tail.	82.93	0.41	12.5
Head (Calculated)	100.00	2.71	100.0

Calculated Grades and Recoveries

Products 1 and 2	2.16	62.6	49.9
Products 1 to 3	3.24	44.3	53.0
Products 1 to 4	17.07	13.9	87.5

Test No. 41

Purpose: To repeat conditions of test No. 40 but use $Pb(NO_3)_2$ in cleaners as per test No. 39.

Procedure: As outlined below.

Feed: 2000 grams minus 10 mesh Mill Feed 3.

Grind: 30 minutes at 59 % solids in the lab ball mill.

Conditions:

Stage	Reagents Added, grams per tonne				Time, minutes			pH
	H_2SO_4	$Pb(NO_3)_2$	3477	MIBC	Grind	Cond.	Froth	
Grind	-	-	-	-	30	-	-	7.9
Condition	500	-	-	-	-	5	-	6.4
Rougher	-	250	20	17.5	-	2	5	6.9
	-	250	10	10	-	2	5	-
	-	125	10	-	-	2	5	-
1st Cleaner	-	50	-	-	-	2	8	7.0
2nd Cleaner	-	25	-	5	-	2	6	7.1
3rd Cleaner	-	15	-	-	-	2	6	6.9

Metallurgical Results

Product	Weight	Assays, %		% Distribution	
	%	Sb	As	Sb	As
1. Sb 3rd Cl. Conc.	3.32	67.0	0.20	79.8	1.8
2. Sb 3rd Cl. Tail.	0.21	24.1	1.20	1.8	0.7
3. Sb 2nd Cl. Tail.	0.79	7.59	0.80	2.2	1.8
4. Sb 1st Cl. Tail.	6.06	2.13	0.80	4.6	13.5
5. Rougher Tail.	89.62	0.36	0.33	11.6	82.2
Head (Calculated)	100.00	2.79	0.36	100.0	100.0

Calculated Grades and Recoveries

Products 1 and 2	3.53	64.4	0.26	81.6	2.5
Products 1 to 3	4.32	54.1	0.36	83.8	4.3
Products 1 to 4	10.38	23.7	0.62	88.4	17.8

Test No. 41 - Continued

Rougher Tailing

Metallurgical Results

Product	Weight	Assays, %	% Distribution
	%	Sb	Sb
1. +74 µm	21.3	0.45	26.7
2. -74 +37 µm	27.1	0.27	20.3
3. -37 +23 µm	13.3	0.22	8.1
4. -23 +12 µm	13.6	0.13	4.9
5. -12 µm	24.7	0.58	40.0
Head (Calculated)	100.0	0.36	100.0

NOTE: 40 % of the antimony losses in rougher tailing were as -12 µm

Test No. 42

Purpose: To repeat conditions of test No. 41 at natural pH

Procedure: As outlined below.

Feed: 2000 grams minus 10 mesh Mill Feed 3.

Grind: 30 minutes at 59 % solids in the lab ball mill.

Conditions:

Stage	Reagents Added, grams per tonne			Time, minutes			pH
	$Pb(NO_3)_2$	3477	MIBC	Grind	Cond.	Froth	
Grind	-	-	-	30	-	-	-
Condition	-	-	-	-	5	-	7.8
Rougher	250	20	17.5	-	2	5	-
	250	10	10	-	2	5	-
	125	10	-	-	2	5	-
1st Cleaner	50	-	-	-	2	8	7.6
2nd Cleaner	25	-	5	-	2	6	7.7
3rd Cleaner	15	-	-	-	2	6	-

Stage	Rougher	1st Cleaner	2nd and 3rd Cleaner
Flotation Cell	1000 gD-1	500 g D-1	250 g D-1

Metallurgical Results

Product	Weight	Assays, %		% Distribution	
	%	Sb	As	Sb	As
1. 3rd Cl. Conc.	3.12	66.9	0.15	75.2	1.2
2. 3rd Cl. Tail.	0.45	13.2	0.48	2.1	0.6
3. 2nd Cl. Tail.	2.03	2.52	0.47	1.8	2.5
4. 1st Cl. Tail.	8.77	1.13	0.42	3.6	9.7
5. Rougher Tail.	85.63	0.56	0.38	17.3	86.0
Head (Calc.)	100.0	2.78	0.38	100.0	100.0

Calculated Grades and Recoveries

Products 1 and 2	3.57	60.1	0.19	77.3	1.8
Products 1 to 3	5.60	39.2	0.29	79.1	4.3
Products 1 to 4	14.37	16.0	0.37	82.7	14.0

Test No. 43

Purpose: To repeat conditions of test No. 41 but clean at pH 6.5 with H_2SO_4.

Procedure: As outlined below.

Feed: 2000 grams minus 10 mesh Mill Feed 3.

Grind: 30 minutes at 59 % solids in the lab ball mill.

Conditions:

Stage	Reagents Added, grams per tonne				Time, minutes			pH
	$Pb(NO_3)_2$	3477	MIBC	H_2SO_4	Grind	Cond.	Froth	
Grind	-	-	-	-	30	-	-	-
Condition	-	-	-	500	-	5	-	6.5
Rougher	250	20	17.5	-	-	2	5	-
	250	10	10	-	-	2	5	-
	125	10	-	-	-	2	5	-
1st Cleaner	-	-	-	125	-	2	-	6.4
	50	-	-	-	-	2		6.5
2nd Cleaner	25	-	5	-	-	2	6	6.3
3rd Cleaner	-	-	-	75	-	2	-	6.2
	15	-	-	-	-	2	6	-

Test No. 43 - Continued

Metallurgical Results

Product	Weight %	Assays, % Sb	% Distribution Sb
1. Sb 3rd Cl. Conc.	4.71	53.4	87.7
2. Sb 3rd Cl. Tail.	1.55	3.59	1.9
3. Sb 2nd Cl. Tail.	4.31	1.20	1.8
4. Sb 1st Cl. Tail.	13.96	0.46	2.2
5. Sb Rougher Tail.	75.47	0.24	6.4
Head (Calculated)	100.00	2.87	100.0

Calculated Grades and Recoveries

Products 1 and 2	6.26	41.1	89.6
Products 1 to 3	10.57	24.8	91.4
Products 1 to 4	24.53	11.0	93.6

Screen Analyses

Combined Products

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 65	0.4	0.4	99.6
100	2.0	2.4	97.6
150	6.6	9.0	91.0
200	11.5	20.5	79.5
270	12.3	32.8	67.2
400	10.7	43.5	56.5
- 400	56.5	100.0	-
Total	100.0	-	-

Test No. 44

Purpose: To repeat conditions of test No. 41 with a finer grind.

Procedure: As outlined below.

Feed: 2000 grams minus 10 mesh Mill Feed 3.

Grind: 40 minutes at 59 % solids in the lab ball mill.

Conditions:

Stage	Reagents Added, grams per tonne				Time, minutes			pH
	H_2SO_4	$Pb(NO_3)_2$	3477	MIBC	Grind	Cond.	Froth	
Grind	-	-	-	-	40	-	-	-
Condition	500	-	-	-	-	5	-	6.5
Rougher	-	250	20	17.5	-	2	5	6.5
	-	250	10	10	-	2	5	-
	-	125	10	-	-	2	5	-
1st Cleaner	-	50	-	-	-	2	8	7.0
2nd Cleaner	-	25	-	5	-	2	6	7.1
3rd Cleaner	-	15	-	-	-	2	6	7.1

Test No. 44 - Continued

Metallurgical Results

Product	Weight %	Assays, % Sb	% Distribution Sb
1. Sb 3rd Cl. Conc.	4.74	53.0	88.6
2. Sb 3rd Cl. Tail.	0.98	2.26	0.8
3. Sb 2nd Cl. Tail.	3.91	1.29	1.8
4. Sb 1st Cl. Tail.	14.81	0.53	2.8
5. Sb Ro. Tailing	75.56	0.23	6.0
Head (Calculated)	100.00	2.84	100.0

Calculated Grades and Recoveries

Products 1 and 2	5.72	44.3	89.4
Products 1 to 3	9.63	26.8	91.2
Products 1 to 4	24.44	10.9	94.0

Screen Analyses

Combined Products

Mesh Size (Tyler)	% Retained Individual	% Retained Cumulative	% Passing Cumulative
+ 100	0.2	0.2	99.8
150	2.2	2.4	97.6
200	7.1	9.5	90.5
270	11.6	21.1	78.9
400	13.5	34.6	65.4
- 400	65.4	100.0	-
Total	100.0	-	-

Test No. 45

Purpose: To repeat conditions of test No. 41.

Procedure: As outlined below.

Feed: 2000 grams minus 10 mesh Mill Feed 3.

Grind: 30 minutes at 59 % solids in lab ball mill.

Conditions:

Time	Reagents Added, grams per tonne				Time, minutes			pH
	H_2SO_4	$Pb(NO_3)_2$	3477	MIBC	Grind	Cond.	Froth	
Grind	-	-	-	-	30	-	-	-
Condition	500	-	-	-	-	5	-	6.5
Rougher	-	250	20	17.5	-	2	5	-
	-	250	10	10	-	2	5	-
	-	125	10	-	-	2	5	-
1st Cleaner	-	50	-	5	-	2	8	-
2nd Cleaner	-	25	-	2.5	-	2	6	-
3rd Cleaner	-	15	-	-	-	2	6	-

Stage	Rougher	1st Cleaner	2nd and 3rd Cleaner
FlotationCell	1000 g D-1	500 g D-1	250 g D-1
Speed: r.p.m.	1650		

Test No. 45 - Continued

3161-45 Metallurgical Balance

Product	Weight %	Assays,% Sb	Assays,% As	% Distribution Sb	% Distribution As
1. Sb Cl Conc	3.44	68.40	0.17	83.11	1.60
2. Sb 3rd Cl Tail	0.50	19.60	1.62	3.44	2.20
3. Sb 2nd Cl Tail	1.03	5.00	1.23	1.82	3.46
4. Sb 1st Cl Tail	6.26	1.15	0.74	2.54	12.57
5. Ro Tail	88.77	0.29	0.33	9.09	80.07
Head(calc)	100.00	2.83	0.37	100.00	100.00
Combined Products					
1+2	3.94	62.24	0.35	86.55	3.80
1to3	4.97	50.37	0.53	88.37	7.27
1to4	11.23	22.93	0.85	90.91	19.93

LAKEFIELD RESEARCH
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